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ON THE CLASSIFICATION OF THE ANIMAL KINGDOM.[1]

BY PROFESSOR T. H. HUXLEY.

LINNÆUS defines the object of classification as follows:—"Methodus, anima scientiæ, indigitat, primo intuitu, quodcumque corpus, naturale, ut hoc corpus dicat proprium suum nomen, et hoc nomen quæcumque de nominato corpore beneficio seculi innotuere, ut sic in summa confusione rerum apparenti, summus conspiciatur Naturæ ordo." ("Systema Naturæ," ed. 12, p. 13.)

With the same general conception of classificatory method as Linnæus, Cuvier saw the importance of an exhaustive analysis of the adult structure of animals, and his classification is an attempt to enunciate the facts of structure thus determined, in a series of propositions of which the most general constitute the definitions of the largest, and the most special, the definitions of the smallest groups.

Von Baer showed that our knowledge of animal structure is imperfect unless we know the developmental stages through which that structure has passed; and since the publication of his "Entwickelungs-Geschichte der Thiere," no philosophical naturalist has neglected embryological facts in forming a classification.

Darwin, by laying a novel and solid foundation for the theory

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[1] Paper read at the Linnean Society, Dec. 4, 1874. Printed from advance proofs corrected by the author.

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of evolution, introduced a new element into taxonomy. If a species, like an individual, is the product of a process of development, its mode of evolution must be taken into account in determining its likeness or unlikeness to other species; and thus "phylogeny" becomes not less important than embryogeny to the taxonomist. But while the logical value of phylogeny must be fully admitted, it is to be recollected that in the present state of science absolutely nothing is positively known respecting the phylogeny of any of the larger groups of animals. Valuable and important as phylogenic speculations are as guides to, and suggestions of, investigation, they are pure hypotheses incapable of any objective test; and there is no little danger of introducing confusion into science by mixing up such hypotheses with taxonomy, which should be a precise and logical arrangement of verifiable facts.

The present essay is an attempt to classify the known facts of animal structure, including the development of that structure, without reference to phylogeny, and, therefore, to form a classification of the animal kingdom which will hold good, however much phylogenic speculations may vary.

Animals are primarily divisible into those in which the body is not differentiated into histogenetic cells (Protozoa), and those in which the body becomes differentiated into such cells (Metazoa of Hæckel).

I. The Protozoa are again divisible into two groups: 1. the Monera (Hæckel), in which the body contains no nucleus; and 2. the Endoplastica, in which the body contains one or more nuclei. Among these the Infusoria, Ciliata and Flagellata (*e.g.*, Noctiluca), while not forsaking the general type of the single cell, attain a considerable complexity of organization, presenting a parallel to what happens among the unicellular Fungi and Algæ (*e.g.*, Mucor, Vaucheria, Caulerpa).

II. The Metazoa are distinguishable, in the first place, into those which develop an alimentary cavity—a process which is accompanied by the differentiation of the body wall into, at fewest, two layers, an epiblast and a hypoblast (*Gastrææ* of Hæckel), and those in which no alimentary cavity is ever formed.

Among the Gastrææ there are some in which the gastrula, or primitive sac with a double wall open at one end, retains this primitive opening throughout life as the egestive aperture; numerous ingestive apertures being developed in the lateral walls of the gastrula—whence these may be termed Polystomata. This group comprehends the Spongida or Porifera. All other Gastrææ are Monostomata, that is to say, the gastrula develops but one ingestive aperture. The case of compound organisms in which new gastrulæ are produced by germination is of course not a real exception to this rule.

In some Monostomata the primitive aperture becomes the permanent mouth of the animal (Archæstomata).

This division includes two groups, the members of each of which are very closely allied:—1. The Cœlenterata. 2. The Scolecimorpha. Under the latter head are included the Turbellaria, the Nematoidea, the Trematoda, the Hirudinea, the Oligochæta, and probably the Rotifera and Gephyrea.

In all the other Monostomata the primitive opening of the gastrula, whatever its fate, does not become the mouth, but the latter is produced by a secondary perforation of the body wall. In these Deuterostomata there is a perivisceral cavity distinct from the alimentary canal, but this perivisceral cavity is produced in different ways.

1. A perivisceral cavity is formed by diverticula of the alimentary canal, which become shut off from the latter (Enterocœla).

The researches of Alexander Agassiz and of Metschnikoff have shown that, not only the ambulacral vessels, but the perivisceral cavity of the echinodermata are produced in this manner; a fact which may be interpreted as indicating an affinity with the Cœlenterates (though it must not be forgotten that the dendrocœle Turbellaria and many Trematoda are truly "cœlenterate"), but does not in the least interfere with the fundamental resemblance of these animals to the worms.

Kowalevsky has shown that the perivisceral cavity of the anomalous Sagitta is formed in the same way, and the researches of Metschnikoff appear to indicate that something of the same kind takes place in Balanoglossus.

2. A perivisceral cavity is formed by the splitting of the mesoblast (Schizocœla).

This appears to be the case in all ordinary Mollusca, in all the polychætous Annelida, of which the Mollusca are little more than an oligomerous modification, and in all the Arthropoda.

It remains to be seen whether the Brachiopoda and the Polyzoa belong to this or the preceding division.

3. A perivisceral cavity is formed neither from diverticula of the alimentary canal nor by the splitting of the mesoblast, but by an outgrowth or invagination of the outer wall of the body (Epicæla).

The Tunicata are in this case, the atrial cavity in them being formed by invagination of the epiblast.

Amphioxus, which so closely resembles an Ascidian in its development, has a perivisceral cavity which essentially corresponds with the atrium of the Ascidian, though it is formed in a somewhat different manner. One of the most striking peculiarities in the structure of Amphioxus is the fact that the body wall (which obviously answers to the somatopleure of one of the higher vertebrata, and incloses a "pleuro-peritoneal" cavity in the walls of which the generative organs are developed), covers the branchial apertures, so that the latter open into the "pleuro-peritoneal" cavity. This occurs in no other vertebrated animal. Kowalevsky has proved that this very exceptional structure results from the development of the somatopleure as a lamina which grows out from the sides of the body and eventually becomes united with its fellow in the middle ventral line, leaving only the so-called "respiratory pore" open. Stieda has mentioned the existence of the raphè in the position of the line of union in the adult animal. Rathke described two "abdominal canals" in Amphioxus; and Johannes Müller, and more recently Stieda, have described and figured these canals. However, Rathke's canals have no existence, and what have been taken for them are simply passages, or semi-canals, between the proper ventral wall of the abdomen and the incurved edges of two ridges developed at the junction of the ventral with the lateral faces of the body, which extend from behind the abdominal pore where they nearly meet, to the sides of the mouth. Doubtless the ova which Kowalevsky saw pass out of the mouth, had entered into these semi-canals when they left the body by the abdominal pore, and were conveyed by them to the oral region. The ventral integument between the ventrolateral laminæ is folded as Stieda has indicated, into numerous close-set longitudinal plaits which have been mistaken for muscular fibres, and the grooves between these plaits are occupied by epidermic cells, so that in transverse section the interspaces between the plaits have the appearance of glandular cæca. This plaited organ appears to represent the Wolffian duct of the higher Vertebrata, which, in accordance with the generally embryonic character of

Amphioxus, retains its primitive form. The somatopleure of Amphioxus therefore resembles that of ordinary vertebrata in giving rise to a Wolffian duct by invagination of its inner surface. But the Wolffian duct does not become converted into a tube, and its dorsal or axial wall unites with its fellow in the raphé of the ventral boundary of the perivisceral cavity.

In all the higher Vertebrata of which the development has yet been traced, the "pleuro-peritoneal" or perivisceral cavity arises by an apparent splitting of the mesoblast, which splitting, however, does not extend beyond the hinder portion of the branchial region. But in many vertebrata (*e.g.*, Holocephali, Ganoidei, Teleostei, Amphibia) a process of the integument grows out from the region of the hyoidean arch, and forms an operculum covering the gill-cleft. In the frog, as is well known, this opercular membrane is very large, and unites with the body wall posteriorly, leaving only a "respiratory pore" on the left side, during the later periods of the tadpole's life. Here is a structure homologous with the splanchnopleure of Amphioxus; while, in the thoraco-abdominal region, the splanchnopleure appears to arise by splitting of the mesoblast. Considering what takes place in Amphioxus, the question arises whether the "splitting" of the mesoblast in the Vertebrata may not have a different meaning from the apparently similar process in the Arthropoda, Annelida and Mollusca; and whether the pericardium, pleura, and peritoneum are not parts of the epiblast, as the atrial tunic is of the epiblast of the ascidians. Further investigation must determine this point. In the meanwhile, on the assumption that the "pleuro-peritoneal" cavity of the Vertebrata is a virtual involution of the epiblast, the peritoneal aperture of fishes becomes truly homologous with the "respiratory pore" of Amphioxus; and the Wolffian ducts and their prolongations, with the Müllerian ducts, are, as Gegenbaur has already suggested, of the same nature as the segmental organs of worms.

The division of Metazoa without an alimentary cavity is established provisionally, for the Cestoidea and Acanthocephala, in which no trace of a digestive cavity has ever been detected. It is quite possible that the ordinary view that these are Gastrææ modified by parasitism is correct. On the other hand, the cases of the Nematoid worms and of the Trematoda show that the most complete parasitism does not necessarily involve the abortion of the alimentary cavity, and it must be admitted to be possible that a primitive gregariniform parasite might become multicellular and might develop reproductive and other organs, without finding any advantage in an alimentary canal. A purely objective classification will recognize both these possibilities and leave the question open.

THE SONG OF THE CICADA.

BY F. C. CLARK, M. D.

It must not be considered that all music is a succession of delightful sounds. Harmony, it is true, depends much upon the construction of the musical apparatus, but it depends still more upon the skill of the operator and the taste of the listener. Hence among the lowest insect tribes, many a rough, rasping note, though awakening no particular delight in us, serves as great a purpose as the more pleasant sounds.

On any warm sunny afternoon, or evening, insect courtships take place in countless numbers under our very eyes if we would only use them. What *Katy-did*, which name the insect has borne for ages, still exercises the imagination of poets and philosophers. We hear it loudly whispered in trees and shrubbery, that something was done by "Katy," but beyond that we are left in utter darkness; though some poets have even attempted to unravel the mystery.

Among still higher orders of animals, as our birds, we find the plumage of the male more brilliant, during the pairing season, and their songs more ravishing than before. At this time they charm the human listener, even as much as the delighted female bird. Even our barn-yard cock, good chanticleer, assumes a bolder front, and echoes his joyous notes over hill and dale.

Rising to mammals, man excepted, we shall observe certain sounds more or less pleasant, but still sufficient to fulfil the object for which they were created.

Therefore from the human family, where music reaches its highest perfection, down to the lowest and meanest insect that utters a sound, each furnishes notes to form the grand harmony of nature, in the great struggle for existence. To a cultivated